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NASA CASE NO. MFS-28997-1

PRINT FIG. # 3

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Serial Number 08/422,961  
Filing Date April 17, 1995  
NASA/MSFC

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*IN-54*  
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*P-17*

### **Automatic Locking Knee Brace Joint**

This invention is an apparatus for controlling the pivotal movement of a knee brace comprising a tang-and-clevis joint that has been uniquely modified. Both the tang and the clevis have a set of teeth that, when engaged, can lock the tang and the clevis together. In addition, the tang is biased away from the clevis. Consequently, when there is no axial force (i.e., body weight) on the tang, the tang is free to pivot within the clevis. However, when an axial force is exerted on the tang, the tang is pushed into the clevis, both sets of teeth engage, and the tang and the clevis lock together.

FIGURE 3 is a perspective view of the invention showing the assembled tang-and-clevis joint. This figure also shows the range of rotation of the tang within the clevis. A preferred embodiment of the invention comprises a tang having a first set of teeth (10), a clevis having a second set of teeth (20), a means for pivotally and slidably mounting the tang within the clevis (40), and a means for biasing the tang away from the clevis (not shown).

In operation, the tang-and-clevis joint is free to rotate provided no weight (i.e., force) is exerted on the joint. As indicated above, when enough weight is exerted on the joint, the teeth engage to automatically lock the joint and the joint remains locked as long as a rotational force in the direction of a knee bend remains on the joint. The joint subsequently unlocks automatically when weight is taken off the leg and the knee is extended.

An object of this invention is to provide a joint for a knee brace that can be easily locked in place with a minimum amount of effort in order to prevent the collapse of a braced leg. Another object of this invention is to provide a joint for a knee brace that will, upon locking, remain locked until all the load has been taken off the joint in order to prevent unanticipated joint slippage.

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PATENT APPLICATION

### **AUTOMATIC LOCKING KNEE BRACE JOINT**

Origin of the Invention: The invention described in this patent was made by an employee of the United States Government and may be manufactured and used by or for the Government for governmental purposes without the payment of any royalties.

### **BACKGROUND OF THE INVENTION**

Field of the Invention: This invention relates to orthotics. Specifically, this invention pertains to a hinge or joint for use in a leg or knee brace.

Background Information: U.S. Patent Number 5,267,950 ('950) entitled "Automatic Locking Orthotic Knee Device" was invented to satisfy the need for a knee brace that could automatically lock in any position in order to prevent a braced leg from collapsing. While '950 partially satisfied this need, a completely different hinge mechanism was found to be necessary in order to completely fulfill the need.

In '950, the automatic locking feature is achieved by using a person's body weight to create a frictional resistance in the joint. When enough force (i.e., the locking force) is exerted on the joint via the brace, the resulting friction locks the joint. There are two disadvantages to this approach. First, the locking force typically cannot be achieved before the brace itself starts to slip on the leg. Consequently, while the joint offers resistance, the joint is not capable of achieving a total lock. Second, the resistance or locking feature is dependent on how much weight is being exerted on the joint. Consequently, an unintended alteration of weight on a braced leg can cause unwanted joint slippage, which could cause the leg to collapse unexpectedly.

#### **SUMMARY OF THE INVENTION**

This invention is an apparatus for controlling the pivotal movement of a knee brace comprising a tang-and-clevis joint that has been uniquely modified. Both the tang and the clevis have a set of teeth that, when engaged, can lock the tang and the clevis together. In addition, the tang is biased away from the clevis. Consequently, when there is no axial force (i.e., body weight) on the tang, the tang is free to pivot within the

clevis. However, when an axial force is exerted on the tang, the tang is pushed into the clevis, both sets of teeth engage, and the tang and the clevis lock together.

Accordingly, an object of this invention is to provide a joint for a knee brace that can be easily locked in place with a minimum amount of effort in order to prevent the collapse of a braced leg.

Another object of this invention is to provide a joint for a knee brace that will, upon locking, remain locked until all the load has been taken off the joint in order to prevent unanticipated joint slippage.

#### **BRIEF DESCRIPTION OF THE DRAWINGS**

Additional details of this invention are explained below with the help of the attached drawings in which:

FIGURE 1 is an exploded view of the invention showing the tang-and-clevis joint.

FIGURE 2 is another exploded view of the invention showing more assembly detail of the tang-and-clevis joint.

FIGURE 3 is a perspective view of the invention showing the assembled tang-and-clevis joint. This figure also shows the range of rotation of the tang within the clevis.

FIGURE 4 is an enlarged elevation view of the teeth on both the tang and the clevis. In this figure, the teeth of the tang are shown partially engaged with the teeth of the clevis.

FIGURE 5 is a perspective view of the tang-and-clevis joint installed on a knee brace.

#### **DESCRIPTION OF THE PREFERRED EMBODIMENT**

A preferred embodiment of the invention comprises a tang having a first set of teeth, a clevis having a second set of teeth, a means for pivotally and slidably mounting the tang within the clevis, and a means for biasing the tang away from the clevis.

FIGURE 1 shows a tang (10) having a first brace attachment end (11) and a pivot end (12). In the preferred embodiment, the tang (10) also has an adjustment slot (13). A first set of teeth (14) on member (15) extend through the adjustment slot (13) and are attached to the tang (10) by securing a plate (16) to the member (15). The adjustment slot (13) allows the first set of teeth (14) to be adjusted to a variety of positions along the tang (10). As will be seen below, this adjustment feature allows the amount of displacement required to lock the joint to be varied in order to meet the needs or desires of an individual user.

FIGURE 1 also shows a clevis (20) having two sides (21, 31). In the preferred embodiment, the clevis (20) is fabricated from two separate semicircular portions (21, 31) rigidly attached together. The clevis (20) has a second brace attachment end (22, 32) and a pivot point (23, 33). In addition, the clevis (20) has a second set of teeth (24, 34) arranged along a constant radius (90 in FIGURE 4) from the pivot point (23, 33). Finally, the clevis (20) has a ledge (25). In the preferred embodiment, the ledge (25) extends in two radial directions from the pivot point (23) and has a width approximately equivalent to the thickness of the tang (10).

Continuing to refer to FIGURE 1, the pivot end (12) of the tang (10) is mounted to the pivot point (23, 33) of the clevis (20) in a manner that allows the tang (10) to pivot (or rotate) within the clevis (20) and to slide into or out of the clevis (20). The rotation is necessary to accommodate the bending of a knee and the slide is necessary to allow the first set of teeth (14) on the tang (10) to engage the second set of teeth (24, 34) on the clevis (20) whereby the tang (10) is rotationally locked to the clevis (20). In the preferred embodiment, the necessary rotation and slide are accomplished by a pin that is secured to the clevis (20) at the pivot point (23, 33) and that passes

through a pivot slot (17) in the pivot end (12) of the tang (10). In FIGURE 1, the pin is shown as a bolt (40) on which a spacer (41) is slidably mounted. Obviously, the necessary rotation and slide can be accomplished by reversing the functions of the tang (10) and the clevis (20) (i.e., the pin could be secured to the tang and passed through a slot in each side of the clevis).

A spring (50) is used in the pivot slot (17) of the tang (10) to bias the tang (10) away from the clevis (20). This bias prevents the first set of teeth (14) on the tang (10) from engaging the second set of teeth (24, 34) on the clevis (20). Consequently, as long as no axial force is exerted on the tang in excess of the force necessary to compress the spring (50), the tang (10) is free to rotate within the clevis (20).

A final feature shown in FIGURE 1 are shields (61, 62) attached to both sides (21, 31) of the clevis (20) adjacent to the second set of teeth (24, 34). The shields (61, 62) serve two purposes. First, the shields (61, 62) allow the first set of teeth (14) to engage the second set of teeth (24, 34) without interference from items such as clothing. Second, the shields (61, 62) help protect against injury to hands and fingers which may be in the vicinity during operation of the joint.



FIGURE 2 shows the same features as FIGURE 1 plus some additional assembly detail. For example, bolts (18) are used to attach the member (15) to the plate (16), screws (63) are used to attach the shields (61, 62) to the clevis (20), and bolts (26) are used to attach the two sides (21, 31) of the clevis (20) together. In addition, FIGURE 2 shows a first leg brace member (70) and a second leg brace member (80). The first leg brace member (70) is secured to the first brace attachment end (11) of the tang (10) with bolts (71) and nuts (72). The second leg brace member (80) is secured to the second brace attachment end (22, 32) of the clevis (20) with bolts (81).

FIGURE 3 shows the invention completely assembled. In addition, the figure demonstrates the rotational limits of the tang (10) within the clevis (20). The limits of rotation are determined by the configuration of the ledge (25) shown in FIGURE 1. Because the ledge (25) extends in two radial directions from the pivot point (23), the tang (10) is prevented from rotating beyond a certain point in one direction (i.e., in the direction of a knee bend) and is also prevented from rotating beyond a certain point in the other direction (i.e., in the direction of a knee extension). Obviously, an additional feature, such as a set

screw, could be used on the ledge (25) to adjust the limits of rotation.

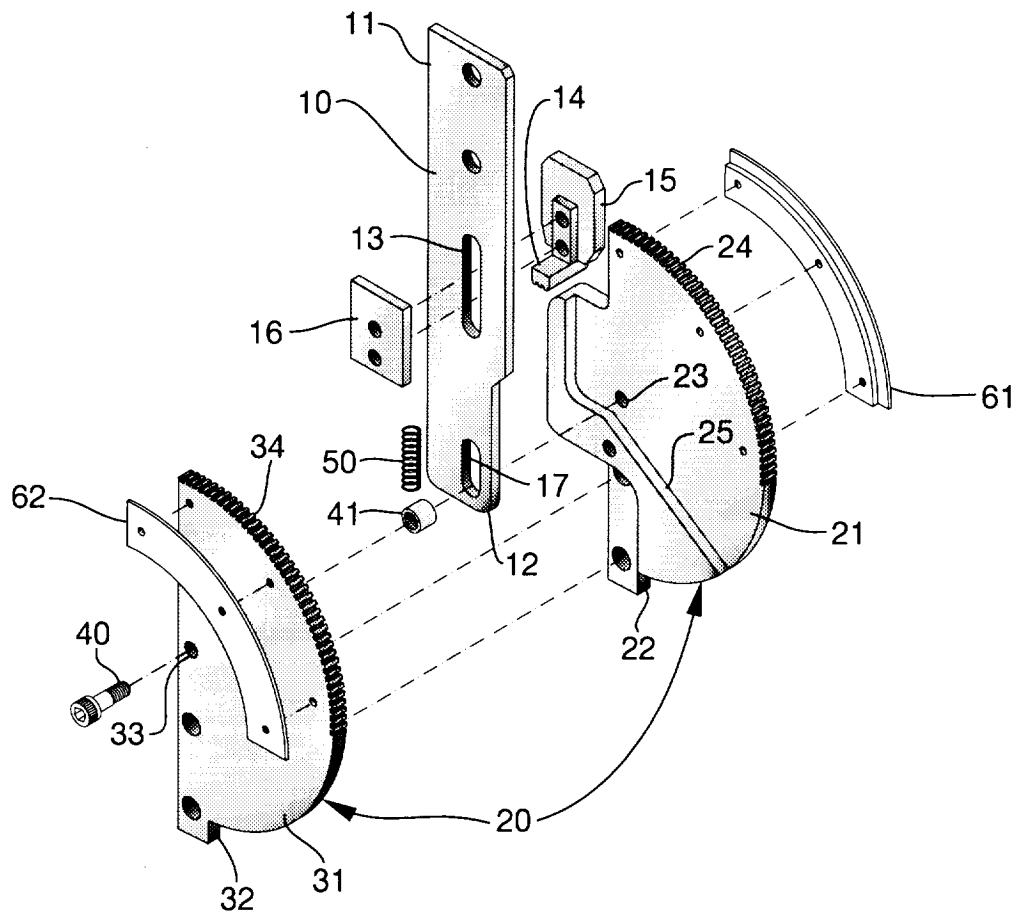
FIGURE 4 shows the preferred shape of the teeth associated with the first and second sets of teeth (14 and 24, 34) of the tang (10) and the clevis (20), respectively. Specifically, both faces of each tooth are sloped to form an angle (91) with the constant radius (90) along which the teeth are arranged. This tooth shape is advantageous because the teeth tend to engage when the tang (10) is rotated in one direction (i.e., in the direction of a knee bend) and tend to disengage when the tang (10) is rotated in the other direction (i.e., in the direction of a knee extension). Thus, once engaged, the first and second sets of teeth (14 and 24, 34) tend to stay engaged in the absence of an axial force on the tang (10) provided at least some rotational force in the direction of a knee bend is applied to the tang (10).

FIGURE 5 shows the invention in conjunction with a knee brace. In operation, the tang-and-clevis joint is free to rotate provided no weight (i.e., force) is exerted on the joint. As indicated above, when enough weight is exerted on the joint, the teeth engage to automatically lock the joint and the joint remains locked as long as a rotational force in the direction of a knee bend remains on the joint. The

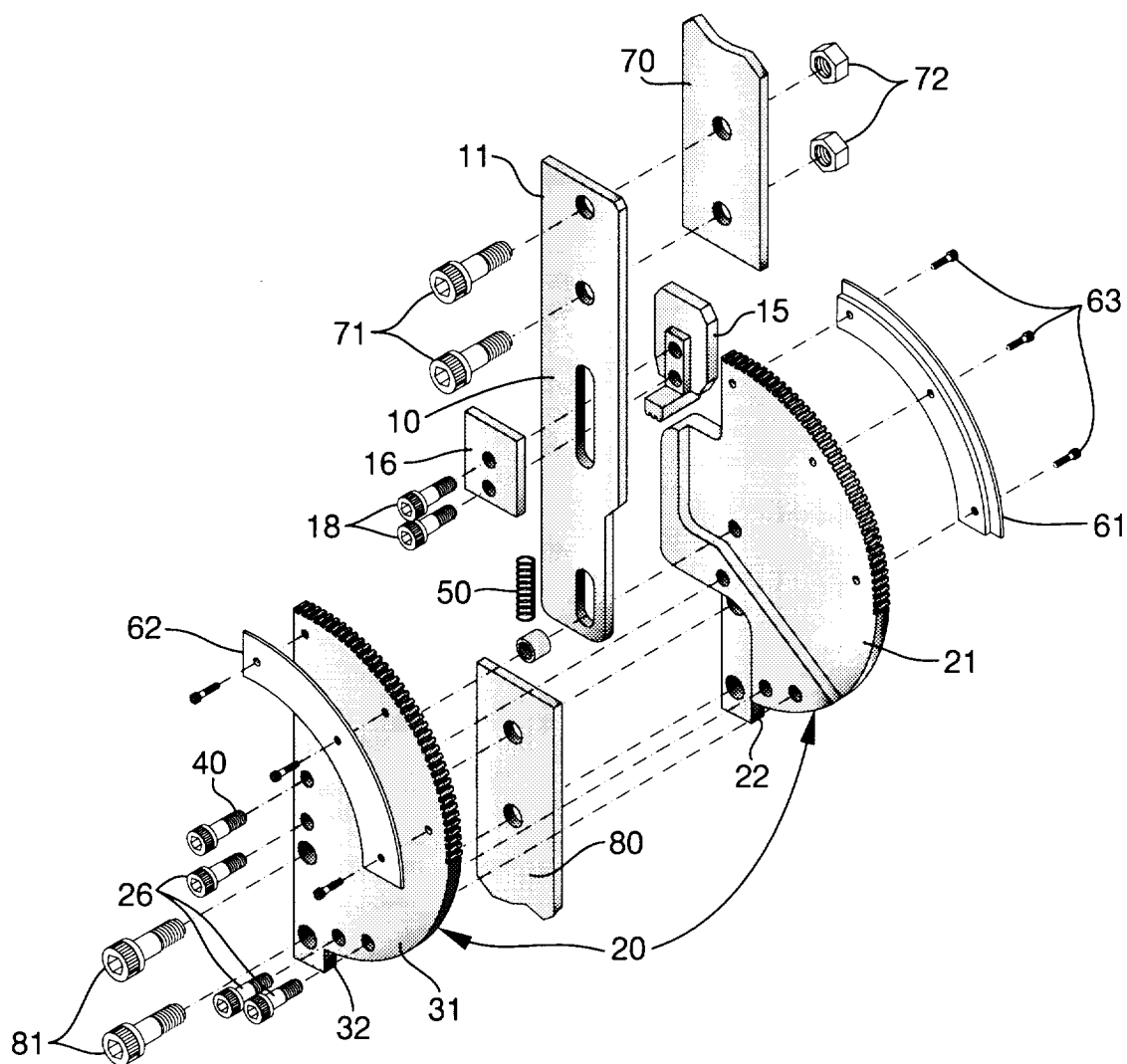
joint subsequently unlocks automatically when weight is taken off the leg and the knee is extended.

**ABSTRACT OF THE DISCLOSURE**

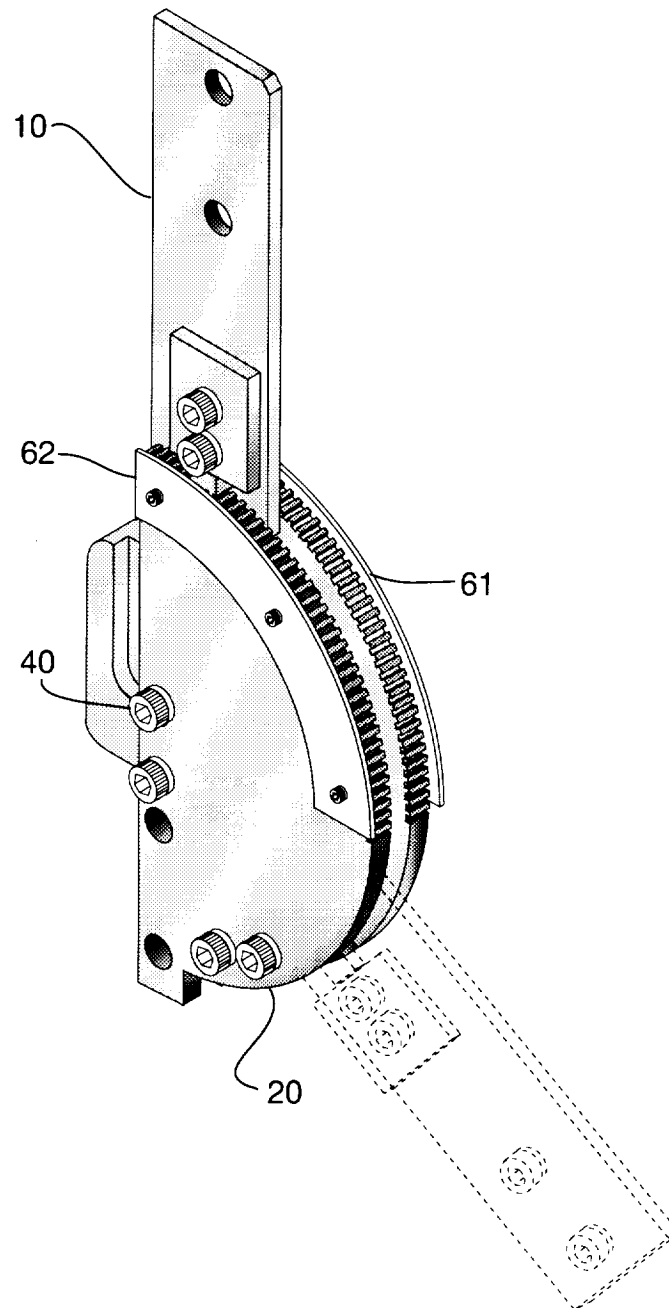
This invention is an apparatus for controlling the pivotal movement of a knee brace comprising a tang-and-clevis joint that has been uniquely modified. Both the tang and the clevis have a set of teeth that, when engaged, can lock the tang and the clevis together. In addition, the tang is biased away from the clevis. Consequently, when there is no axial force (i.e., body weight) on the tang, the tang is free to pivot within the clevis. However, when an axial force is exerted on the tang, the tang is pushed into the clevis, both sets of teeth engage, and the tang and the clevis lock together.



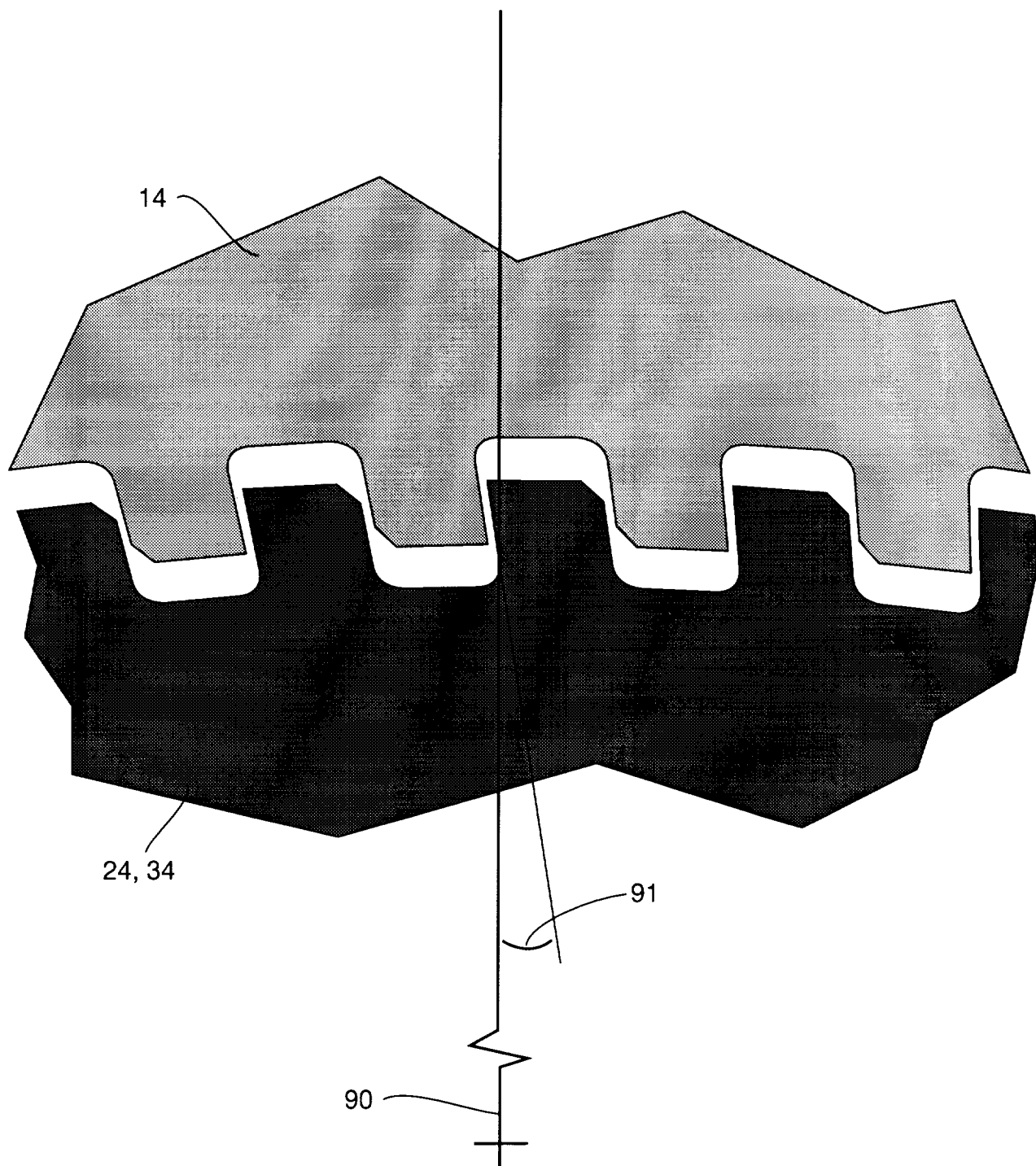
**FIGURE 1**



**FIGURE 2**

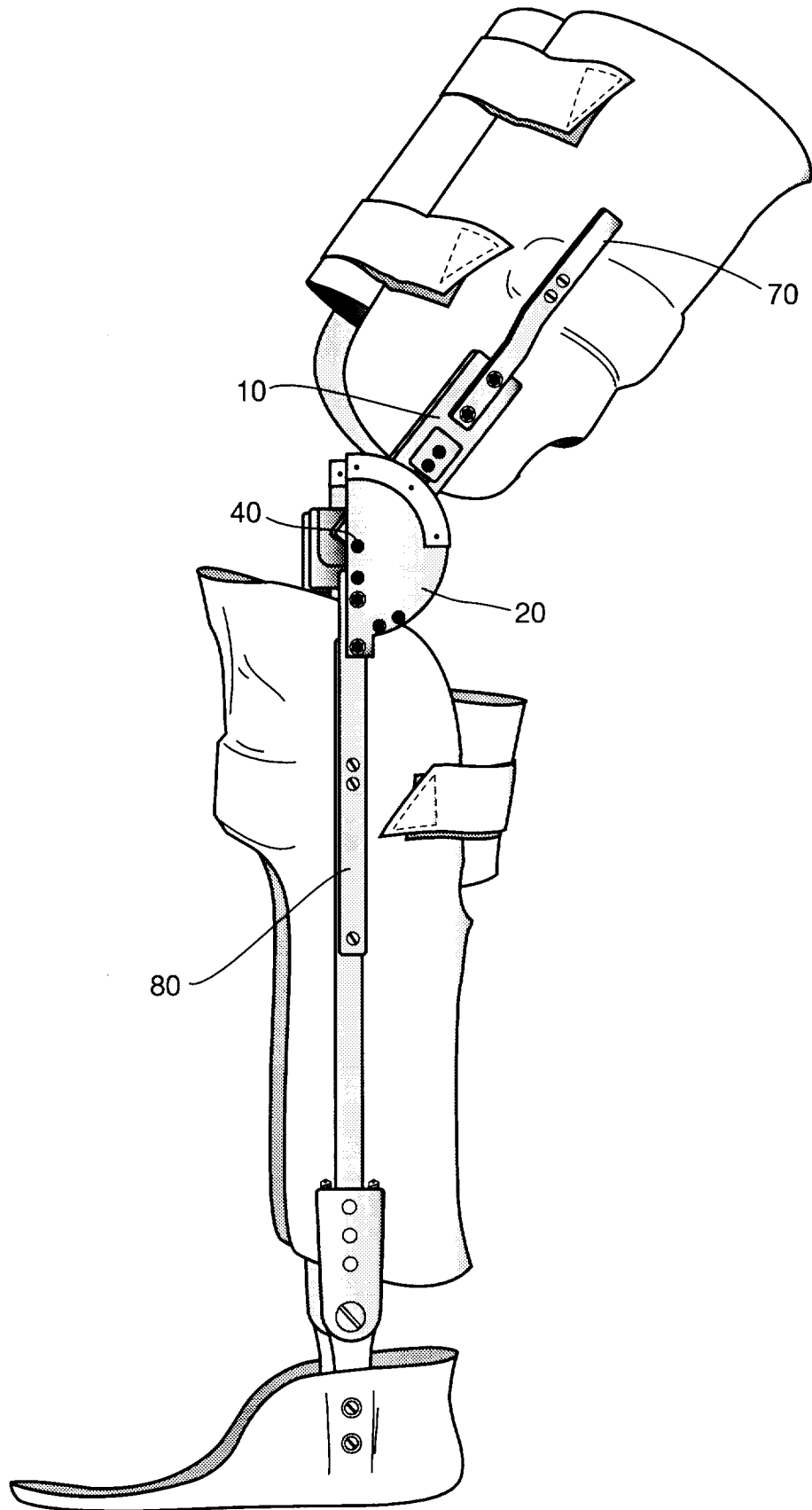


**FIGURE 3**



**FIGURE 4**





**FIGURE 5**